

REMARKS

The above-noted cancellation of claims 1-14 and 21, the amendment of claims 15-20 and 22, and the addition of new claims 23-37, are respectfully submitted in response to the official action dated August 7, 2008. The amendment to claim 15 essentially adds the limitations of prior claim 21 thereto, which claim was already recognized by the Examiner as being directed to allowable subject matter. New claim 23 is similar to prior claim 15, but also includes the requirement for an initiator along with the first and second vinyl monomers thereof. The use of an initiator is specifically set forth at page 11, line 4 of the specification, and this claim clearly does not include any new matter therein. Finally, new claim 31 is essentially based on prior claim 20. It is thus clear that no new matter is included in these amendments, and reconsideration and allowance of these claims is therefore respectfully solicited.

The background of the present invention is based in large part upon U.S. Patent Nos. 5,922,417 and 5,830,604, as discussed in the specification, which relate to methods for treating the surfaces of hydrophobic polymers used in non-woven fabrics so that they can be wetted by water in aqueous solutions. The thrust of this prior art has, in turn, been based upon attempts to render the fabric surfaces permanently wettable, while at the same time preserving the physical properties of the fabric itself, including its tensile properties and porosity. This has not proven to be a simple task, however. The assignee of these two prior U.S. patents (which is also the assignee of the present application) has previously developed a technique for grafting hydrophilic monomers onto the surfaces of the non-woven fabric using ultraviolet radiation initiated copolymerization reactions. In accordance with the present invention, the specific problem of

controlling the amount of polymeric material which is grafted to the surfaces of the fabric fibers themselves has been faced and now overcome. The reason for doing this is to minimize potential loss of the porosity of the fabric as a result of the grafting reaction itself. Indeed, that loss of porosity increases dramatically as the amount of grafted monomer increases. The reason for this is that the grafted material tends to swell when exposed to aqueous media. At the same time, however, while it is extremely desirable to control the amount of monomer provided on the fiber surfaces, it is also very important that the surfaces be coated uniformly. If not, the resultant properties of the product produced therefrom can be significantly compromised, because the fabric cannot then be wetted throughout its thickness by aqueous media. Thus, for example, in the context of an electrode separator for an electrochemical device such as a battery, incomplete separator wetting can increase the internal resistance of the device.

The present invention overcomes all of these problems by using a solution containing two monomers, and by careful control of the reaction conditions. One of these monomers is more reactive than the other monomer, and the selection of reaction conditions enables discrimination between the two monomers because of their different reactivities. As will be seen by the discussion which follows, none of the prior art cited by the Examiner discloses this technique as set forth in the present method claims, and therefore, reconsideration and allowance of this application is respectfully solicited.

Claims 1-7, 9-15, 18-20, and 22 have been rejected as being anticipated by or obvious over Lazear under 35 U.S.C. § 102(b) or 103(a). Lazear is said to set forth a hydrophilic monomer treated microporous film and a process for making same, which film can be polypropylene. The process thereof is said to involve impregnating the microporous film

with a solution of vaporized hydrophilic monomer dissolved in a solvent to form a pad bath which is used in a squeeze roll method where the film is guided through the bath and squeezed between a pair of squeeze rolls for pressure exertion such that the monomer is impregnated within the film. The hydrophilic monomers are said to be organic hydrocarbons of from 2 to 18 carbon atoms with at least one ethylenically unsaturated double bond and at least one polar group, such as carboxy, sulfo, sulfino, hydroxyl, ammonio, amino, or phosphone. (Col.13 ll.26-28.) The monomer is said to be controllably polymerized or copolymerized for chemical fixing to the film surface to render it hydrophilic or controlling within certain limits to avoid plugging the pores, in order to control its water permeability and electrical resistance. Examples of the monomers are set forth at column 13, lines 30-52 and are said to read on the claims. The Examiner then admits that Lazear does not expressly teach that the first vinyl monomer comprises an ethylenically unsaturated carboxylic monomer or ester thereof, such as acrylic acid, or that the second monomer is selected from the groups found in claim 12. However, the Examiner states that the reference provides sufficient guidance for one to experiment with different combinations of the polar group by the teaching of copolymerization. The motivation to do so is said to be a reasonable expectation of either improving the properties or obtaining the same success as in the reference, and without evidence of unexpected results, the burden is said to have shifted to applicants. Lazear is also said to teach the monomer amount chemically fixed to the film controlled to not greater than 10% and generally from 0.1% to 10%. This rejection is respectfully traversed in view of the above amendments and arguments and for the reasons set forth hereinafter.

The cancellation of claims 1-7 and 9-14 clearly renders the rejection of these claims moot. We therefore turn

our attention to claims 15, 18-20, and 22. Of course, the Examiner has already stated that claim 21, whose limitations have been added to claim 15, is patentable over this art. It is therefore clear that at least these claims are fully patentable over Lazear. However, a brief discussion of the inapplicability of Lazear to these claims, and to the additional claims added herein, is in order.

Lazear itself, after discussing various prior known techniques for rendering polyolefinic films wettable, states that this can be accomplished, and the film rendered hydrophilic, by coating the surface of the micropores of the normally hydrophobic polyolefinic open-celled microporous film with a hydrophilic organic hydrocarbon monomer of from 2 to 18 carbon atoms and including at least one double bond and at least one polar functional group, and then chemically fixing to the surface of the micropores an amount of the hydrophilic organic hydrocarbon monomer sufficient to preserve the open celled structure by irradiating the coated film with ionizing radiation. In each of the examples set forth in the Lazear patent, electron beam radiation sources are employed, which is clearly the preferred source of ionizing radiation in Lazear. Thus, once the film coated with the monomer has been exposed to this type of radiation, the reaction between the film polymer and the monomer is said to proceed very quickly and indiscriminately. Thus, the only method of limiting the amount of monomer grafted to the film is by restricting the amount of monomer present within the pores of that film. In columns 15-17 of Lazear, there is set forth a discussion of the techniques by which this controlled amount of monomer can thus be provided. This preferably includes contact with a vapor of the monomer, which condenses on the microporous structure and is controlled by control of the equilibrium vapor pressure described therein. Other methods disclosed therein include dissolving the monomer

in a vaporizable solvent to form a pad bath, and/or using reverse roll coating, squeeze rolling, and wire-wound metering rod methods or techniques. Thus, the characteristics of the product produced by Lazear will depend on these steps and the provision of monomer on the surfaces of the porous sheet. The uniformity of the coating of grafted monomer can detrimentally affect the properties of the finished product. Thus, if the surfaces remain uncoated, they are incapable of being wetted by aqueous solutions in subsequent applications. These results are thus fundamentally inconsistent with the objectives of that patent, such as when the product is to be used as a battery separator, in which case nonwetted surfaces will lead to increases in internal electrochemical resistance. The potential disadvantages of the various techniques taught in Lazear are clear. With the squeeze roll method, for example, the regions of the film which may be left without any coating of the vinyl monomer again leave these regions unwettable.

All of this can be vividly contrasted with the present invention. In the presently claimed technique, a totally different approach is taken. By utilizing a carefully selected system of monomers in which one monomer effectively inhibits the polymerization reaction of the other monomer, clearly superior results can be achieved. Furthermore, the claims require that this reaction be initiated using ultraviolet radiation. By using this reaction system, the solution of the vinyl monomers can fill the pores of the product so that the monomers are effectively present in excess. This assists in minimizing the likelihood of surfaces of the article remaining untreated. By using the system of the present invention, including the required two monomers hereof, as well as the initiator, the more-reactive monomer reacts with the less-reactive monomer, which then becomes incorporated into the grafted chains themselves. However, these chains containing the less-reactive

monomer are then less likely to react any further. The chain length can thus be controlled by adjusting the likelihood of reaction of the chains with the two monomer species. Thus, the product of the reaction of the grafted chains is determined by the relative concentrations of the two monomer species in solution. Shorter chains can thus be obtained by reducing the concentration of the reactive monomer compared with that of the less-reactive monomer.

Lazear, on the other hand, includes no teaching or suggestion whatsoever of using a solution of first and second monomers as required by the present claims. Certainly there is no suggestion of applying such a solution with an initiator as required by claim 23, for example.

In order to appreciate the benefit of using the present invention as compared to that of Lazear, reference should be made to the examples in the present specification. In particular, the second table in Example 1 demonstrates that the weight increase on grafting is less when the solution includes vinyl sulfonic acid or vinyl phosphonic acid as a second monomer, as compared to when the solution contains acrylic acid alone. Furthermore, the wettability characteristics of the reacted product with the second monomers is good, as shown by the short wet-out times and high wicking heights. These products thus have the highly desirable properties of (a) controlled coating thickness and (b) good wettability, as compared with the technique which is the subject of the prior patents discussed above, as well as Lazear. The result of using a combination of monomers in an ultraviolet radiation initiated reaction in accordance with this invention thus provides significant and unforeseeable benefits in terms of the ability to use excess monomer solution while still controlling the amount of monomer grafted to the polymer substrates thereof.

It is therefore respectfully submitted that these claims are clearly patentable over Lazear, and reconsideration and withdrawal of this rejection is respectfully solicited.

Claims 1-5, 7-11, 13 and 14 have been rejected as being anticipated or obvious over McLoughlin *et al.* under 35 U.S.C. § 102(e) or 103(a). The Examiner contends that McLoughlin *et al.* teaches a separator of non-woven fabric appearing to be microporous, comprising substantially unbound fibers and vinyl monomers capable of reacting with an acid or base to form a salt directly or indirectly by a reaction involving exposure to UV radiation while impregnating with a solution of vinyl monomer copolymerizable with the surface of the fibers, which are preferably polypropylene. This rejection is respectfully traversed in view of the above amendments and arguments and for the reasons set forth hereinafter.

It is initially noted that each of claims 1, 5, 7-11, 13 and 14 have been canceled, so that this rejection no longer appears to be applicable. In addition, this earlier patent, also by the assignee of the present application, relates to the admitted state of the art in disclosing the known UV initiated grafting techniques of the applicants' assignee. Once again, and as indicated by the Examiner's application of this reference only against claims which have now been canceled, there is no disclosure therein whatsoever directed to use of the combination of monomers specified in each of the claims now set forth in this application. Furthermore, applicants would once again emphasize the significance of the present invention, as is made abundantly clear by the examples herein. In the second table in Example 1, as discussed above, the weight increase on grafting is less when the solution includes vinyl sulfonic acid or vinyl phosphonic acid as the second monomer than when the solution contains acrylic acid alone. Thus, the characteristics of the product in accordance with the present invention are clearly not

realizable with the prior art references, including McLoughlin *et al.*

Claims 1-8, 10-13, 15, 16, 18-20, and 22 have been rejected as being anticipated or obvious over Sugo *et al.* under 35 U.S.C. § 102(b) or 103(a). The Examiner contends that Sugo *et al.* sets forth in Examples 1 and 4-6 a method comprising impregnating a non-woven fabric with a solution comprising a mixture of acrylic acid or an acrylic acid ester and trimethylvinylbenzyl ammonium salt or a sodium salt of styrenesulfonate, which is said to be a type of vinyl sulphonic acid salt, and exposing it to radiation. The Examiner admits that, although the examples teach electron beam irradiation, Sugo *et al.* teaches that ultraviolet is acceptable. Finally, Sugo *et al.* is also said to teach a substrate that appears to be modified in the same manner as those instantly claimed, and without the ability to conduct experimentation, the burden of establishing unobviousness by objective evidence is shifted to applicants. This rejection is respectfully traversed in view of the above amendments and arguments and for the reasons set forth hereinafter.

The Sugo *et al.* reference is directed to the production of polymeric electrolyte complexes by exposing a shaped organic polymer to an ionizing radiation and then introducing cationic and anionic groups into the polymer by means of graft copolymerization of a monomer with cationic groups and a monomer with anionic groups. Furthermore, the background section of Sugo *et al.* discusses the known coating of these complexes onto substrates, such as woven or non-woven fabrics. The substrate of the invention in Sugo *et al.* is said to be advantageously made of material such as polyethylene.

Sugo *et al.* represents a rather broad shotgun teaching for forming grafted chains on polymer substrates. The thrust of Sugo *et al.* is directed to producing ion exchange materials,



with an emphasis on grafting as much of an ion exchange monomer onto a substrate as possible. Thus, all of the examples refer to graft yields of at least 60% (presumably by weight) and frequently well over 100%. It is not surprising, however, that this is the case, since achieving high graft yields is important when the resulting material is intended for ion-exchange applications in which performance will be dependent on the amount of material grafted onto a substrate. It is thus also apparent why the background section in the Sugo *et al.* patent specifically refers to these materials existing as gel-like materials which, when coated onto substrates such as fabrics, cause the interstices of the fabrics to become filled. This can again be vividly contrasted to the present invention which is concerned with an entirely different problem; namely, creation of a grafted coating on the surfaces of a porous article in order to change the wettability of those surfaces, but otherwise, to the extent possible, maintaining the porous structure. The present invention seeks to limit as far as possible the amount of monomer grafted to the article surfaces consistent with making them wettable. The experimental data in the present application demonstrates this, such that the weight increase resulting from the grafting reaction is clearly less than 1% and, in any event, significantly less than 10%, illustrating the significant difference between this invention and that disclosed in Sugo *et al.*

The specific limitations of the present invention as set forth in the claims define how these results are achieved. Thus, use of ultraviolet radiation to initiate the reaction applied to the porous article while it is being impregnated with the monomer solution is one important element. Sugo *et al.* does make passing reference to irradiation of a substrate while it is impregnated with a solution, but states that this is disadvantageous because of homopolymer formation (see col.2

11.18-25). Furthermore, at line 5 of column 2 in Sugo et al., ionizing radiation is discussed, and various types of radiation are mentioned including ultraviolet radiation. However, in every example in Sugo et al., high energy electron beam radiation is used to initiate the reaction. Furthermore, the electron beam radiation is used in a pre-irradiation step performed on the substrate before it even encounters the monomer solution. The cited substrate can then react with the monomer in a subsequent reaction. As is made clear by the examples, this involves heating the substrate while it is soaked in the monomer solution to elevated temperatures of from 40°C to 70°C for a period of several hours. This can be vividly contrasted with the single-step reaction used in the present invention, which is completed in a matter of seconds.

Thus, both the methods of the present invention and the products which are produced by those methods are clearly and significantly different from the methods disclosed in Sugo et al. and the products produced thereby.

All of these differences arise from the degree of discrimination which can be achieved in accordance with the present invention, which cannot be achieved by Sugo et al.'s process. Again, this arises from use of the reaction of an initiator, such as a photoinitiator, when the reaction system including both the polymeric article and the impregnating solution of monomers and initiator are irradiated. This creates radicals such that the first monomer forms grafted chains and the second monomer reacts with the grafted chains, but such that the second vinyl monomer does not itself form grafted chains. This is in complete contrast to Sugo et al. in which the entire purpose is to create grafted chains of sodium styrene sulfonate or trimethyl vinyl benzyl ammonium salt.

Finally, as for claims such as claim 31, while Sugo et al. is said to suggest broad numbers of monomer materials,

the specific materials of claim 31 are not mentioned therein. Once again, the examples demonstrate the benefits of using these materials, such as Example 1 discussed above. This results in the highly desirable properties discussed above, none of which is even suggested nor could be produced by Sugo *et al.*

It is therefore respectfully submitted that all of the claims now set forth in this application possess the requisite novelty, utility and unobviousness to warrant their immediate allowance, and such action is therefore respectfully solicited. If, however, for any reason the Examiner does not believe that such action can be taken at this time, it is respectfully requested that he/she telephone applicant's attorney at (908) 654-5000 in order to overcome any objections thereto.

Finally, if there are any additional charges in connection with this requested amendment, the Examiner is authorized to charge Deposit Account No. 12-1095 therefor.

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Respectfully submitted,

By 

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